lec 1

Microwave Engineering

what is meant by microwaves ?

It means that we deal with alternating (current or voltage) signals with frequency from 300 MHz → 300 GHz

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{300\times10^6} = 1\,m$$

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{300\times10^9} = 1\,mm$$

∴ λ (1mm → 1m) millimeter waves

Course contents:

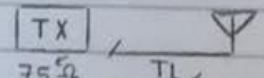
1. Transmission line theory
2. Transmission lines and wave gudes
   a. parallel wire T.L
   b. parallel plate T.L
   c. rectangular w.G
   d. circular w.G
   e. Strip line
   f. microstrip line
3. Impedance matching and tunning.

1. Transmission line theory:

define transmission line ?

- is a mean to convey the signal from point to point.

- is also known as the feeder that connects the transmitter to its antenna.



(mismatch)

$$\Gamma = \frac{Z_{in} - Z_o}{Z_{in} + Z_o}$$

- لو الـ T.L ماشي مظبوط صفقد جزء كبير من الـ signal ..
- أخطر حاجة في أي Communication system أن الـ freq. يكون عالي ..

Transmission lines can be used to construct the following components:

1. Inductor
2. Capacitors
3. resonance circuit
4. filters
5. Couplers
6. transformers
7. Insulators
8. stub matching

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Advantages of microwaves and its applications:

1- antenna gain is proportional to the antenna electrical size.
≡ as the frequency increase, the antenna electrical size increase and the gain increase.

dipole antenna

$\Rightarrow$ Lant = 3λ → electrical length.
→ wave length.
↳ phase length

$L_{ant} = x \cdot \lambda \rightarrow x = f(f)$

$\uparrow G \propto f \uparrow \propto x \uparrow$

Ex:
for antenna of length 3m operate at $f_1 = 300\,MHZ$, $f_2 = 3000\,MHZ$ find x_1, x_2.

sol

$f_1 = 300\,MHZ$

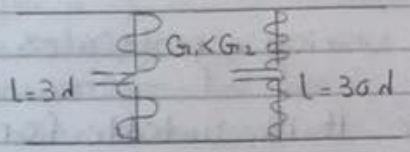
$d_1 = \frac{c}{f_1} = \frac{3\times10^8}{300\times10^6} = 1\,m$, $L_{ant} = x_1 \cdot d = 3m$

$\therefore x_1 = \frac{3m}{d_1} = \frac{3m}{1m} = 3 \rightarrow L_{ant} = 3d$.

$f_2 = 3000\,MHZ$

$d_2 = \frac{c}{f_2} = \frac{3\times10^8}{3000\times10^6} = 0.1\,m$, $L_{ant} = x_2 \cdot d_2 = 3m$

$x_2 = \frac{3m}{d_2} = \frac{3m}{0.1} = 30 \rightarrow L_{ant} = 30d$



Gain $= G = \frac{4\pi}{d^2} = A_{eff}$

↳ antenna effective area.

$G \propto \frac{1}{d^2}$

2- more bandwidth can be relized at higher frequencies.

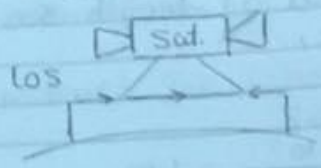
→ for a certain frequency, the Bandwidth around that frequency is taken as 1% of that frequency

Ex:

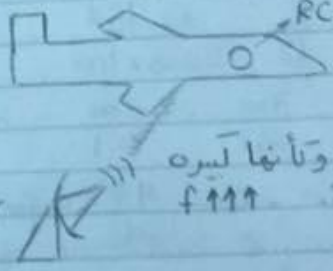
at $f = 600\,MHZ \rightarrow B.w = \frac{600MHZ}{100} = 6\,MHZ$

at $f = 60\,GHZ \rightarrow B.w = \frac{60\times10^9}{100} = 60\times10^7 HZ = 600MHZ$

3- Microwaves travel by line of sight (los) and are not bent by the ionosphere.
So, they are suitable for:
1- Satellite Communications.
2- terrestrial Communications.



4- The effective Reflection area (Radar cross section) increase as the frequency increase.
- So it is suitable for Radar applications



5- Various molecules and atoms resonate of microwave frequencies
So, it is suitable for:
1- heating
2- diagnosis and treatment.
3- remote sensing.